A spatial-temporal statistical approach to command and control problems in battle-space digitization

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Abstract

There are considerable difficulties in the integration, visualization, and overall management of battle-space information for the purpose of Command and Control (C2). One problem that we see as being important is the timely combination of digital information from multiple (possibly disparate) sources in a dynamically evolving environment. That is, there is a need to assimilate incoming data rapidly, so as to provide the battle commander with up-to-date knowledge about the battle-space and thereby to facilitate the command-decision process. In this paper, we present a spatial-temporal approach to obtaining accurate estimates of the constantly changing battlefield, based on noisy data from multiple sources. Specifically, we examine the danger posed to a theoretical warfighter in the combat theater. The danger-potential field generated by an enemy's weapons is defined in the spatial domain and is later extended to incorporate the temporal dimension. We propose that maps of fields of this sort are very effective decision tools for the battle commander. Kalman-filtering techniques are proposed to facilitate the rapid estimation of these danger-potential fields. Methods of displaying these predictions and the uncertainty associated with them are discussed. It is the quantification of uncertainty in C2 predictions that distinguishes our statistical approach from deterministic approaches. An application is given to a data set generated by an object-oriented combat-simulation program that we have developed.